

THERMAL PLUME STUDY OF
THE MT. TOM PLANT OF
HOLYOKE WATER POWER COMPANY

MOUNT TOM STATION
HOLYOKE WATER POWER COMPANY
MASSACHUSETTS

Thermal Plume Studies

Biological Studies

Conducted by the
Division of Fisheries and Game
Bureau of Wildlife Research and Management
Commonwealth of Massachusetts

for

Northeast Utilities Service Company
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Introduction

The Mt. Tom Power Station is located east of Route 5 in Holyoke, Massachusetts. This section of the Connecticut River is regarded as Class "B" water. Class "B" water is suitable for swimming and recreation, a good area for fishing, suitable for agricultural and industrial purposes, and if properly treated, permissible to drink. This section of the river is slow flowing and subject to considerable fluctuation due to alteration of the river flow by the Turners Fall Dam and the Holyoke Dam for hydroelectric generating purposes. Average river flows during the months of June through September ranged from 3800-9700 cubic feet per second (Table 1). The plant circulates from 2-5.3% of the water flowing by the plant.

Mt. Tom's daily output is approximately 150 MW. The fuel source for its boilers is oil. The Mt. Tom plant takes in 200.5 cubic feet of water per second or 90,000 gallons of water per minute for cooling plant condensers. It is then discharged back into the river approximately 15°F above the ambient river temperature. This discharge water cannot exceed 98°F in accordance with standards set by the Division of Water Pollution Control and the Environmental Protection Agency. The plant also adds chlorine once daily, to river water passing through the condensers as a biocide. This is to prevent aquatic growths from building up in the water circulating systems. The water is returned directly to the river, and the concentration of chlorine in the effluent cannot be above 0.1 ppm in compliance with EPA regulations.

The Holyoke Water Power Company was issued an order by the Massachusetts Water Resources Commission, Division of Water Pollution Control to initiate a biological study at the Mt. Tom steam electric generating station as a condition on application for a discharge permit.

Following discussions between the Deputy Director of the Massachusetts Division of Fisheries and Game, Mr. Colton H. Bridges, and the company's Fish and Wildlife Consultant, Lyle M. Thorpe, a mutually agreed upon study proposal was developed and approved by the Division of Water

Pollution Control. This study outlined procedures for detecting and quantifying such changes as may have been caused to the aquatic environment by the discharge of heated water and biocides from the plant. Arrangements were made with the Division of Fisheries and Game to conduct the study with funds provided by the company.

The study focused on benthic organisms, chlorine analysis, fish entrapment studies, fish sampling, plankton collection and determining the three dimensional configuration of the thermal plume. Figure 1 shows the location of sampling stations. The time of year the study was conducted covers maximum plant operation and minimum river flow, which could produce the maximum potential impact on the ecosystem.

Thermal Plume Determination

To determine the configuration and characteristics of the thermal plume, the shoreline was marked at 100 foot intervals beginning at a point 100 feet above the discharge and proceeding downstream 3,600 feet, a point that had been established as being below the $2^{\circ}\text{F}\Delta\text{T}$ influence of the plume. A rope with floats attached every 50 feet extending perpendicular to the shore was used to establish transects. Additional stations (Figure 2) were located along certain transects for vertical temperature and dissolved oxygen profiles.

Temperature and dissolved oxygen measurements were made using a Y.S.I. Model 51, temperature-oxygen meter and probe. In locating the thermal plume, temperature was measured along the transect every 50 feet until surface temperature was within two degrees Fahrenheit of the normal river temperature. At each 50 foot interval along the transect, temperature was recorded at two foot intervals down to the river bottom. On a scale map, isotherms were plotted at 2°F intervals to the point of $\pm 2^{\circ}\text{FAT}$. All temperatures were measured in Centigrade and later converted to Fahrenheit.

Figures 3 and 6 show surface temperatures for June 24-27, 1974, and August 26-27, 1974. Figure 3 approximates the time of the shad run. Surface temperatures during maximum ambient river temperature and minimum river flow are shown in Figure 6. When Figures 3 and 6 are compared a noticeable difference in size and shape is seen. The surface area of the plume in August spread downstream approximately 1,200 feet further than in June and across to the opposite shore. This was due to a decrease in river flow. In Figure 5 the 79°F isotherm curves upstream; this was caused by brisk winds blowing upstream in this area. The bottom temperature contour configuration is shown in Figures 4, and 7. The area of the thermal plume in contact with the bottom of the river was larger in June (5 acres) than in August (3 acres). This was caused by increased river flow, and hence, delayed floatation of the plume.

Vertical series of temperature and dissolved oxygen concentrations were measured using a Y.S. I. Model 51 temperature and oxygen probe (Figures 2 & 3). Dissolved oxygen did not vary greatly except where the

heated effluent enters the river. The dissolved oxygen concentration was increased approximately 3 mg/l, which is attributed to the turbulence of the discharge.

Chlorine Analysis

The Mt. Tom Power Station adds, on a daily morning basis, approximately thirty gallons of 12% sodium hypochlorite solution to its intake water over a thirty minute period to act as a biocide in the condensers. Chlorine analysis was coordinated with the plant's chlorinating schedule to analyze for maximum total available (residual) chlorine being discharged into the Connecticut River.

To determine what portion of total available chlorine of the discharge water was actually introduced by the plant, river water above the plant was also analyzed for total available chlorine, and this value was then deducted from the readings obtained from the discharged waters (Table 4). Effluent limitations established by the Massachusetts Division of Water Pollution Control allow for a maximum of 0.1 ppm total residual chlorine being discharged into the environment.

To analyze total residual chlorine at levels of 0.1 ppm or smaller, the DPD Ferrous Titrimetric method was chosen, as cited in Standard Methods for the Examination of Water and Wastewater, 13th edition. This method was utilized for two reasons; a) it provides one of the more accurate means of differentiating free available chlorine, in the form of hypochlorous acid and/or hypochlorite ion, and combined available chlorine, chloramines and other chloro derivatives at levels less than 0.1 ppm, and b) ease of field performance.

The sampling procedure employed was as follows: Using 100 ml volumetric flasks, samples were collected simultaneously from above the intake and in the discharge proper. Free available chlorine and combined chlorine concentrations were determined for both stations. The total available chlorine equals the sum of the free available chlorine plus the combined chlorine. The value for the total available chlorine from above the intake was subtracted from the value of total available chlorine from below the discharge to give the actual amount of total available chlorine introduced by the plant into the river. Sampling times were between 1100 and 1300 hours. During mid-summer sampling, when water temperatures were above 80°F foam was observed at the time of chlorination.

Samples were taken on four dates: July 31, August 2, August 7, and September 24, 1974. The total available chlorine in the river above the intake varied from 0.016-0.074 ppm and averaged approximately 0.05 ppm. The total available chlorine in the discharge water varied from 0.06-0.353 ppm. The first sampling date revealed the highest total available chlorine level being added to the receiving water - 0.305 ppm. Company personnel were notified of the high levels and took corrective measures. The average total available chlorine added to the receiving

water for the following 3 dates was approximately 0.079 ppm. The presence of chlorine in the river at the observed levels above the intake may be attributed to a sewer effluent entering the river upstream from the town of Easthampton's sewer outfall. This outfall is located on the same side of the river as the plant, approximately 4,000 feet upstream.

Plankton

Plankton sampling was conducted to compare gross abundance at six different stations located within and outside of the thermal plume (Figure 1). Plankton levels were affected by a variety of factors such as volume of flow and currents, temperature, sunlight and other environmental factors.

Although the quantity of plankton occurring at a particular station is subject to all these influences and is continuously changing, sampling was done to determine if, at a given time pronounced differences between gross abundance within and outside of the plume existed, and whether these differences were the result of the plant's thermal discharge and/or chlorination process.

The edge of the plume was easily discernable because a scum line formed at its edge. This line consisted of debris, detritus and organic matter from the Easthampton sewer outfall, and enabled one to outline the general area of the plume. The size and shape of the plume varied greatly at different times during the summer, depending on river flow and wind conditions.

Two stations were located outside the plume - station A above the intake and E along the plume's outer edge. Stations B, C, D, and F were located within the plume, B directly below the discharge and F near the downstream end of the plume. Sampling was conducted on four dates. On the first three dates, samples were analyzed for ash-weight. On the fourth sampling date, samples were analyzed for ash-free weight. The procedures used were as follows:

1. At each station, a meter net was held over the side of a boat approximately 6-12 inches below the surface for approximately ten minutes.
2. The volume of water passing through the meter was recorded with a T.S.K. flow meter No. 2653 and the number of revolutions converted to cubic meters.
3. A one-liter sample was collected.
4. Ash weights were determined by filtering the sample through filter paper using an aspirator, placing it in a drying oven at approximately 60°C for about 24 hours, then reducing it to ash in

a weighed crucible at approximately 600°C for 30 minutes, cooling to room temperature, and then determining the weight of the ash.

5. On the last sampling date, ash-free weight was determined using the following procedure: Each liter sample was reduced to approximately 125 ml by filtering it through a very small plankton net, the contents of which were then rinsed into a tarred crucible. The crucible with plankton was then placed in a drying oven and dried to a constant weight at 105°C for 25 hours. It was cooled to room temperature and dry weight recorded. The crucible was then placed in a muffle furnace at 500°C for 1 hour. It was then cooled, the ash rewetted with distilled water, and placed in a drying oven and dried to a constant weight at 105°C for 24 hours. The ash was then cooled to room temperature and weighed. The weight of crucible and ash was subtracted from the weight of the crucible and dried plankton to obtain the ash-free weight.

Sampling results are listed in Table 5. Comparison of ash-weights showed no discernable pattern of influence by the thermal plume. A considerable part of the ash was probably composed of non-planktonic materials. This method of sampling did not exclude detritus and organic matter from the sample. The Easthampton sewer outfall contributed an undetermined amount of non-planktonic material and made accurate quantification of results difficult. Samples from Station B contained a large amount of particulate matter churned up from the bottom by the turbulence of the discharge. To reduce introduced error from foreign inorganic materials in samples, the ash-free weight determination was substituted on the last sampling date. This method reduces the amount of error caused by non-planktonic inorganic materials but does not exclude organic matter introduced in the sample as sewage particles and floating organic debris such as insect cases. The data from this sampling does not provide sufficient evidence to show quantitative effects on the planktonic populations in the river by the thermal plume.

Benthic Sampling

Ten benthic sampling stations were selected at specific points above and in the thermal plume, Figure 1. Stations 1 and 2 were control stations located above the plume; 4, 6, 7 and 9 were located along the edge of the plume; 3, 5 and 8 were directly in the plume, and 10 was located downstream of the plume.

Benthic sampling was conducted on a monthly schedule. A Petersen dredge, which takes a one square foot, sample was employed. Due to the varying compactness of the substrate the number of dredge hauls per station varied from 2 to 5. Material from all hauls at each station were sieved in a standard series using a 1 mm size screen as the final mesh

size. Rubble, sticks and other large substrate were examined by hand and rinsed to remove any attached organisms. All samples from each station were placed in labeled jars with river water and brought back to the laboratory for sorting. Benthic organisms were picked from the sand and detritus and preserved in a solution of 70% alcohol. Organisms were later identified to order using a 10X - 60X microscope and invertebrate keys by Pennak (1953) and Ward and Whipple (1946).

A summary of the benthic sampling is given in Table 6. Diptera was found to be the most dominant organism, comprising 77% of the total organisms sampled. Ephemeroptera made up 12%, Annelida 3% and Trichoptera 2% of the sample. Eleven other orders represented less than 6% of the total sample.

Diversity indices are another method of measuring and comparing benthic communities. The condition of the benthic communities at the 10 stations was determined by using the diversity index formula found in Biological Field and Laboratory Methods published in 1973 by the Environmental Protection Agency.

$$\bar{d} = \frac{C}{N} (N \log_{10} N - \sum n_i \log_{10} n_i)$$

d = diversity index

C = 3.321928

N = total number of individuals in the sample

n_i = total number of individuals in the order

The diversity of macroinvertebrates is dependent upon the substrate; the more varied the substrate the more varied the diversity of the fauna. However, other limiting factors such as depth, temperature, dissolved oxygen and other water quality criteria can affect the diversity and cause dominance by one or two orders. As noted in Figure 7 and Table 7, Stations 3 and 5 are both directly affected by the heated effluent, there being a 6°-9°F temperature increase over normal river conditions. Stations 2, 3, and 9 have identical substrate yet their diversity indices are 1.82, 0.3 and 1.4 respectively. Station 3, with a diversity index of 0.3 is indicative of the impact that the effluent has on the river bottom in this area. Station 9, while being somewhat affected by the thermal discharge shows recovery as the diversity index approaches that of Station 1, which was not influenced at all by the thermal discharge. Maximum area affected by the discharge varied from three to five acres, depending on river flow conditions (Figures 4 and 7).

The dissolved oxygen concentrations (Tables 2 and 3) were more than adequate at all the sampling stations so that a lack of oxygen could not be considered a limiting factor. The influence of depth on the benthic organisms could not be ascertained due to the lack of similar bottom substrate and locations with respect to the plume. Data shows that the amount and variety of macroinvertebrates are affected by substrate and temperature, but water quality, depth and velocity influences could not be taken into account.

Fish Sampling

Sampling, primarily to determine fish behavior in relation to the thermal plume, was conducted from the beginning of July through the end of August on a bi-weekly schedule. Methods for sampling included electrofishing and gill netting. Electrofishing comprised 99% of the sampling effort. Two sampling stations along the shore were studied within and above the plume. Both study areas were approximately the same size, 1,800 feet in length. Fish sampled were weighed to the nearest 0.1 of a pound and measured to the nearest 0.1 inch.

Gill nets were drifted at night in the vicinity of the thermal plume in mid-June to observe the effects of the thermal effluent on the American shad. No shad were netted; this might be attributed to the lateness of the sample. It was impossible to drift a net directly in the plume because of the shallow depth (four foot maximum).

Katz (1972) studying the migratory behavior of American shad in that section of the Connecticut River above the Holyoke Dam observed no change or alteration in migrating shads behavior due to the Mt. Tom heated discharge. Hughes (1974), personal communication, tracked five sonic tagged shad in the vicinity of the Mt. Tom power plant. Preliminary results show that the migrating shad were not affected in any way by the thermal discharge. The thermal discharge, under spring flow conditions, flows close to the westerly shore of the river, where the river is shallow. Shad migrating in this section of the river pass along the easterly shore in the deeper, main channel (Figure 9). During late summer sampling, countless juvenile shad were observed in both sampling areas. The temperature of the thermal discharge water was measured up to 92°F, yet this high temperature did not seem to have any adverse influence on the numbers of young-of-the-year shad at either sampling station.

Experimental gill nets 150 feet long by 6 feet deep with panels of different mesh size ranging from 3/4 inch to 2 inches were used. Setting gill nets proved to be ineffective in the plume because of the shallow depths. The gill nets set above the thermal discharge, because they were set deeper were more productive. No fish were taken in the plume while white suckers and channel catfish were caught above the discharge.

Electrofishing in the thermal plume collected twelve species of fish, which composed 62% of our total sample, while 14 species, comprising 38% of the fish sample were found above the thermal plume (Tables 9 and 10). The weight of the fishes sampled in the plume was 67.3 pounds, and the weight sampled above the discharge was 39.5 pounds which was consistent with the greater number of fish being sampled in the plume, 83 and 50 respectively, (Tables 9 and 10). More white perch were sampled in the thermal plume than above, 17:1, while more yellow perch were sampled above the plume than in it, 21:1. Largemouth bass and pumpkinseed were sampled upstream, but not in the plume. Numerous eels were observed in both stations, but not collected.

The robustness of a fish is determined by condition factor (C). The formula used to determine the condition factor is as follows:

$$C = \frac{W}{L^3} \times 1,000$$

C = condition factor

W = weight (lbs)

L = length (in.)

An analysis of the condition factor between fish sampled in and above the thermal discharge was conducted to determine if the heated waters affected the robustness of the fish in the plume (Figure 11). Because length and weight are used to compute a condition factor, an adverse environmental condition would have an affect on the condition factor of a fish. The t-test was used to determine if there was any significant difference between the two condition factors. Yellow perch, black crappie, and white crappie were the only species that indicated significant differences and this may be attributed to the small sample sizes.

Fish Impingement

When the plant was activated the intake was equipped with an electric fish screen or barrier of Burkey design as a precautionary measure. At that time there were no detailed data on the distribution of fish in the plant site area and, indeed, no information other than the manufacturer's claims, that such a device would prevent fish from entering the intake.

Over the years of operation, plant personnel have observed but few fish in the screen washings but no systematic attempt to arrive at the magnitude of such fish impingement was undertaken. In connection with this study to evaluate the environmental impact of the thermal plume on the aquatic biota, it was recommended by the regional office of the Environmental Protection Agency that some sampling technique designed to provide a basis for estimating impingement losses be initiated. This was done.

The resident species of the pool are primarily lake and pond species living in a modified riverine environment. Apparently they tend to occupy relatively quiet areas out of strong currents during the winter and until after subsidence of spring floodwaters. They then exhibit considerable movement, probably in response to the spawning urge, and tend to be distributed quite widely throughout the pool during the summer months. These spring movements cause many of them to come into, or pass the plant site area, and make them vulnerable to being drawn into the intake.

Anadromous species, particularly American shad and blueback herring, must pass the plant in going to and from spawning areas above. Their juveniles produced above the plant, must pass it during emigration and, in fact, large numbers of them occupy this reach of the river during the summer.

The sampling program that was adopted called for counting and identifying all fish that were impinged on the screens during a twenty-four hour period each week. These fish were visually sorted into two size groups, i.e., those more or less than 3 inches in total length. Modification to the screen washings outlet retained the fish for counting and identification during sampling periods.

Table 12 is a compilation of the fish impinged during each sampling period, listed by species and size group. The assumption was made that each sampling period was representative of the fish impinged during that week and the actual counts expanded by a factor of 7 (shown in parentheses) to approximate the total weekly impingement losses. While this procedure does lack precision, we believe it is sufficiently accurate to support the conclusion that impingement losses at this plant are acceptably low and do not exert any measurable effect on the fish population.

Some additional comments and observations are in order. Shad and river herring pass the plant on their spawning run but they do not come into the plant intake (the one shad recorded was one of several dead specimens floating in the river and was observed being drawn into the intake). Sonically tagged shad have consistently passed the plant on the far side of the river. Juvenile shad and river herring are abundant in the plant site area during the summer but do not enter the intake. No attempt was made to record the condition of the impinged fish but the evidence is that some of them were dead or moribund when they entered the intake; some were in an advanced state of decomposition. Since impingement of fish occurs to a much lesser degree during late fall, winter and early spring months, it is assumed that the impingement losses shown in Table 12 are essentially representative of the entire year of 1974.

Conclusions

The impact of the Holyoke Water Power, Mt. Tom fossil fueled steam electric generating station heated discharge on the Connecticut River cannot be totally assessed due to the lack of comparative data prior to the plant becoming operational. Additional pollution sources above the power plant which have degraded water quality over the years must also be considered as factors complicating this study.

This short-term biological evaluation concentrated effort on areas of potential environmental impact on plankton, benthic organisms, and fish. The power station's chlorination process did not increase the total residual chlorine levels in heated discharge water to levels above Massachusetts standards. Plankton results were inconclusive and no quantitative effects could be derived. Macroinvertebrates were affected the greatest. Sampling stations located in warmer sections of the heated effluent had lower diversities, which could also reflect effluent velocity effects, while those downstream, under little or no effect from the effluent, exhibited higher

diversities. Some resident fish species appeared to favor the heated effluent and are concentrated there -- approximately twice as many fish were sampled in the thermal plume as above.

It is concluded that during the summer of 1974 the river flow and plant operating conditions produced only a minimal impact on the plankton, benthic organisms, and fish within the area affected by the heated discharge.

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FIGURE 1. SAMPLING STATIONS FOR CHLORINE, PLANKTON,
BENTHIC ORGANISMS, and ELECTROFISHING

JUNE 1, 1974 - SEPT 6, 1974

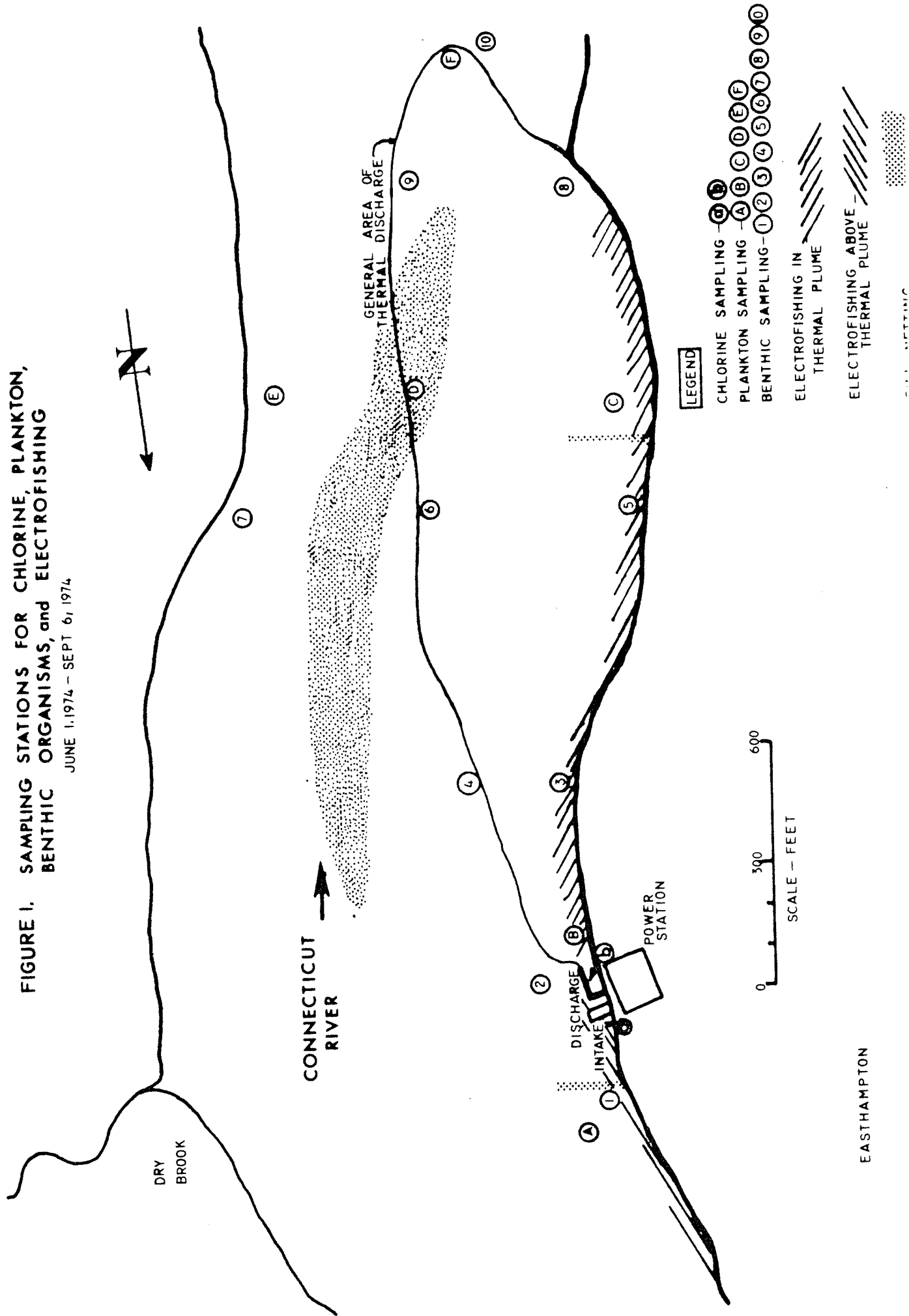


FIGURE 2. DISSOLVED OXYGEN and TEMPERATURE
PROFILE STATIONS

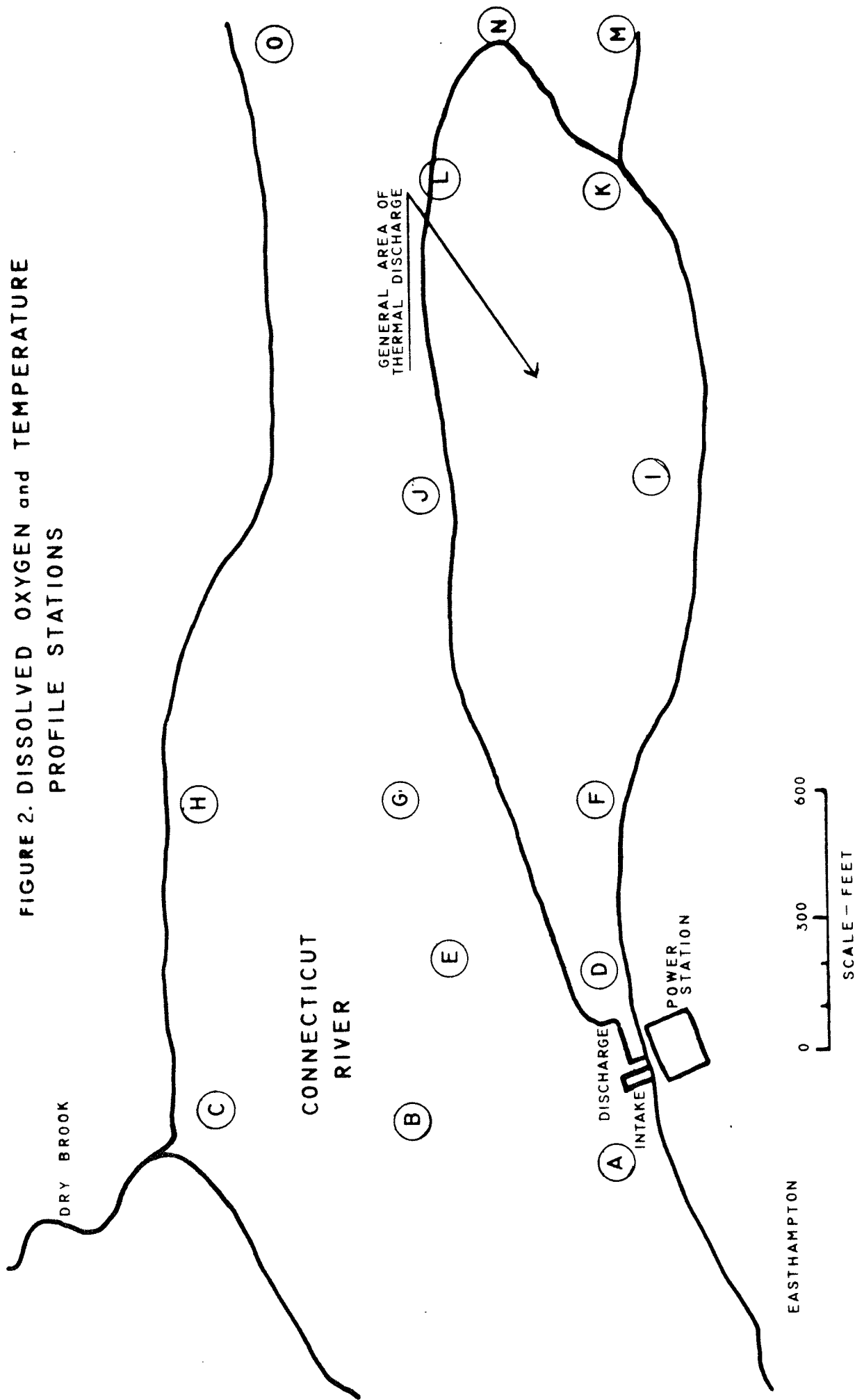
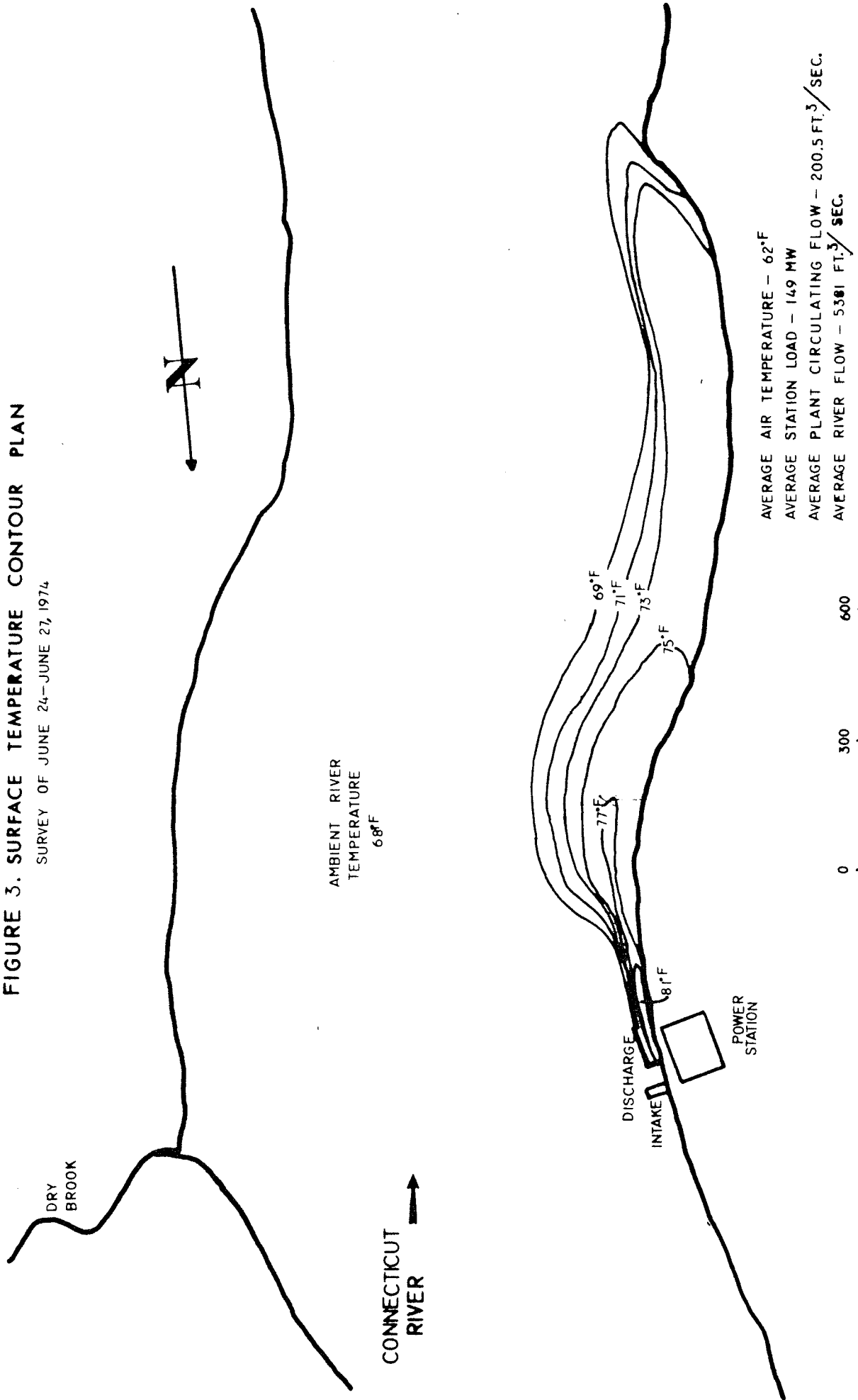


FIGURE 3. SURFACE TEMPERATURE CONTOUR PLAN

SURVEY OF JUNE 24-JUNE 27, 1974



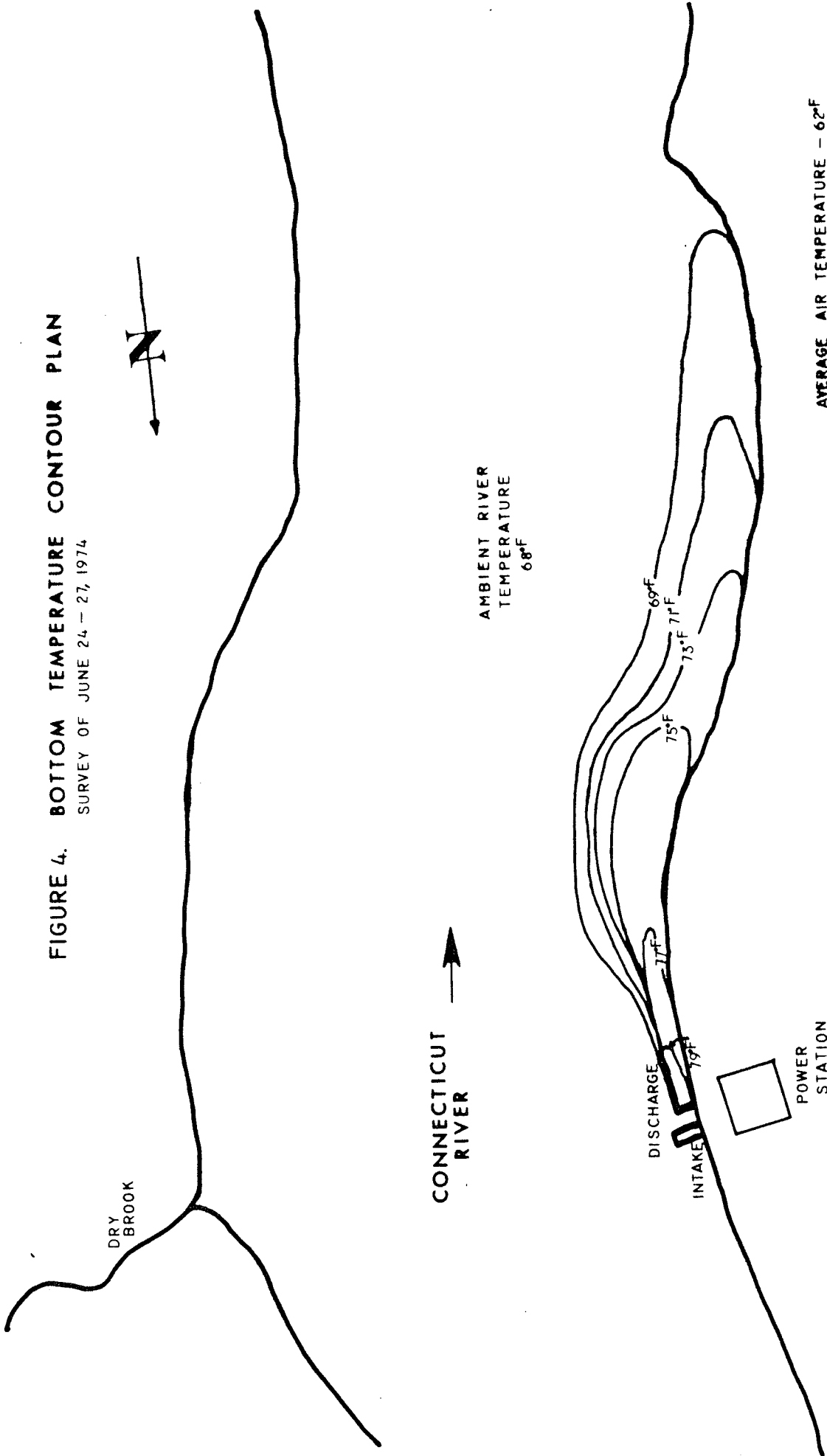


FIGURE 4. BOTTOM TEMPERATURE CONTOUR PLAN

SURVEY OF JUNE 24 - 27, 1974

FIGURE 5. VERTICAL TEMPERATURE TRANSECT THROUGH
LENGTH of THERMAL PLUME
SURVEY OF JUNE 24 - JUNE 27, 1974

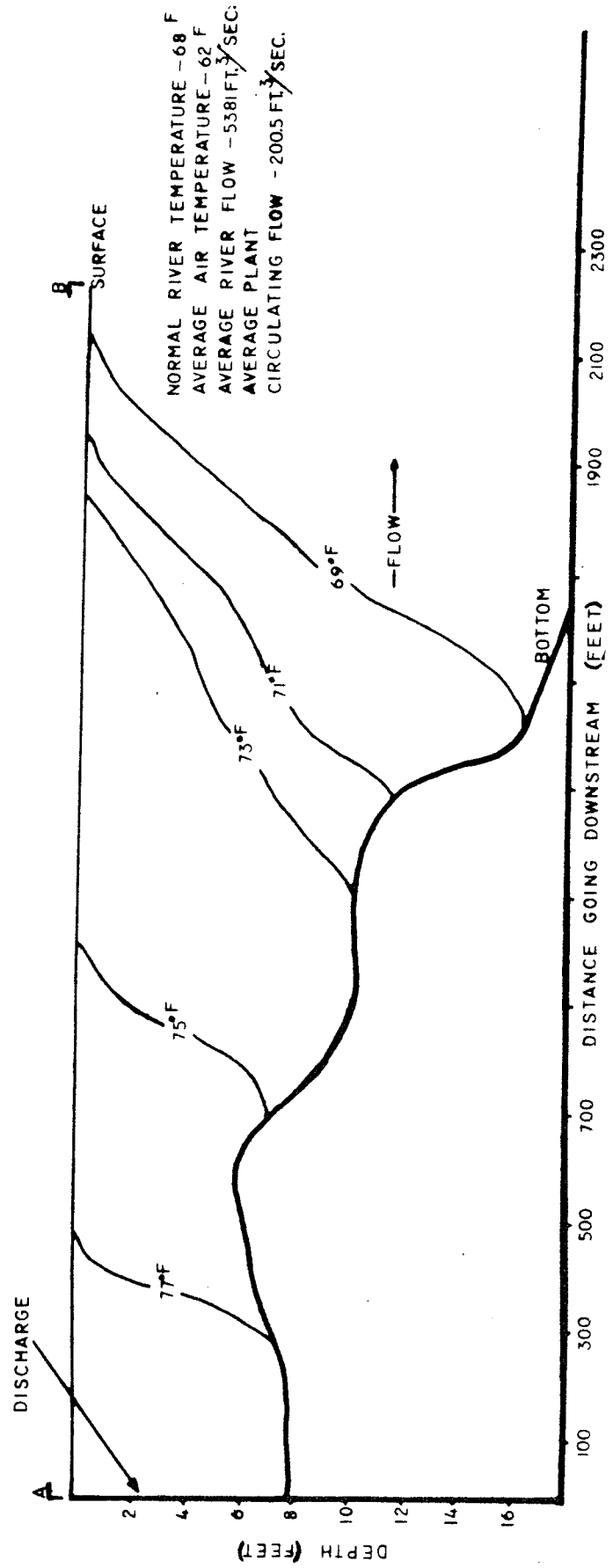
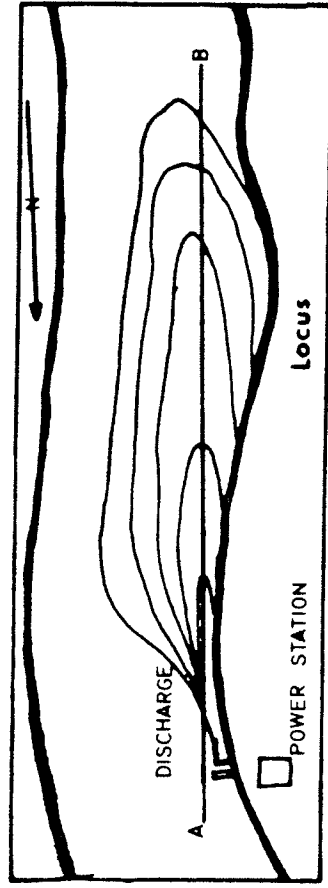


FIGURE 6. SURFACE TEMPERATURE C NTOUR PLAN
SURVEY OF AUGUST 26 - 27, 1974

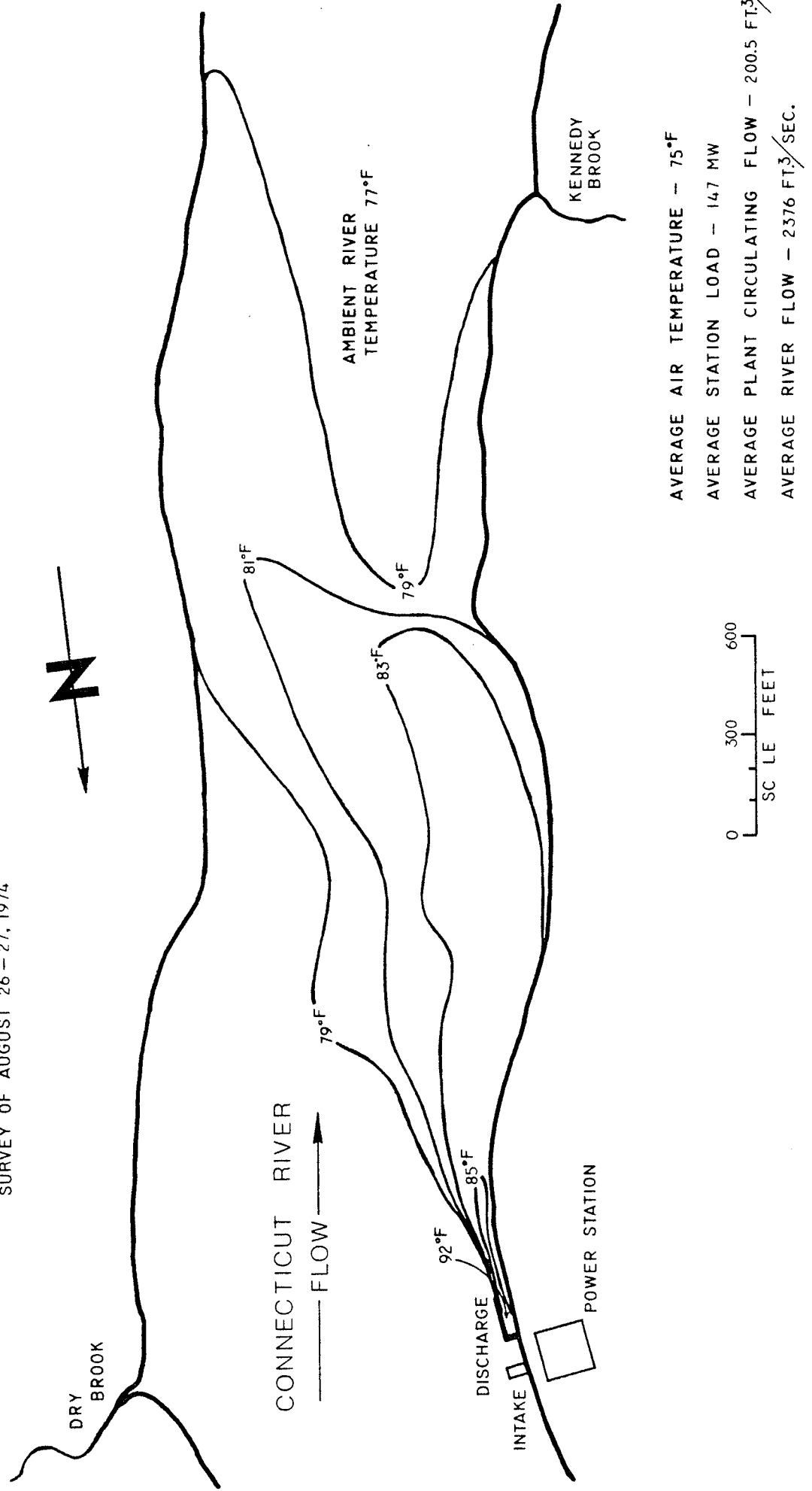
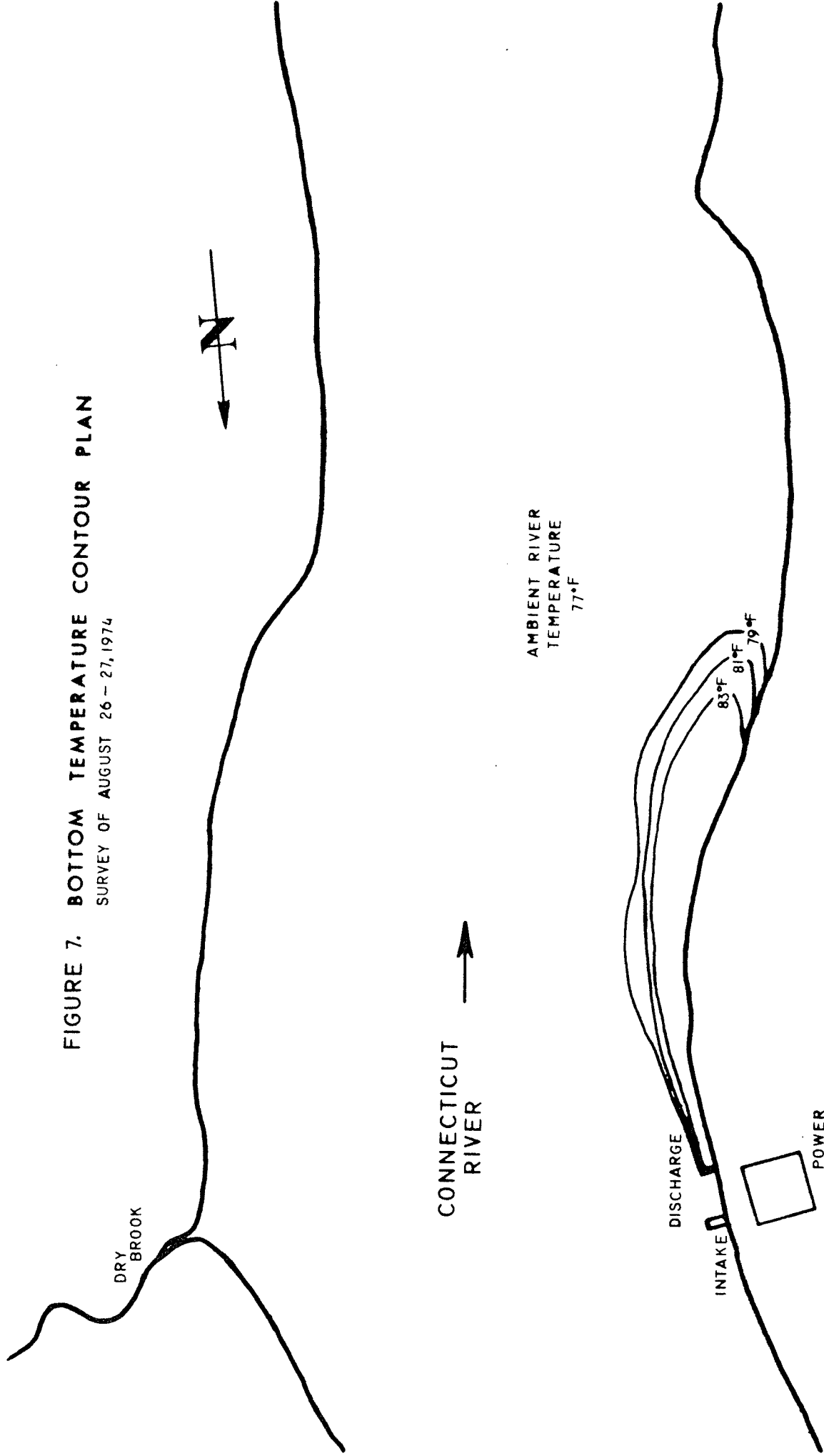


FIGURE 7. BOTTOM TEMPERATURE CONTOUR PLAN
SURVEY OF AUGUST 26-27, 1974



AMBIENT RIVER TEMPERATURE 77°F
 AVERAGE AIR TEMPERATURE - 75°F
 AVERAGE STATION LOAD - 147 MW
 AVERAGE PLANT CIRCULATING FLOW - 200.5 C.F.S.
 AVERAGE RIVER FLOW - 2376 C.F.S.

FIGURE 8. VERTICAL TEMPERATURE TRANSECT THROUGH
LENGTH OF THERMAL PLUME
SURVEY OF AUGUST 26 - 27, 1974

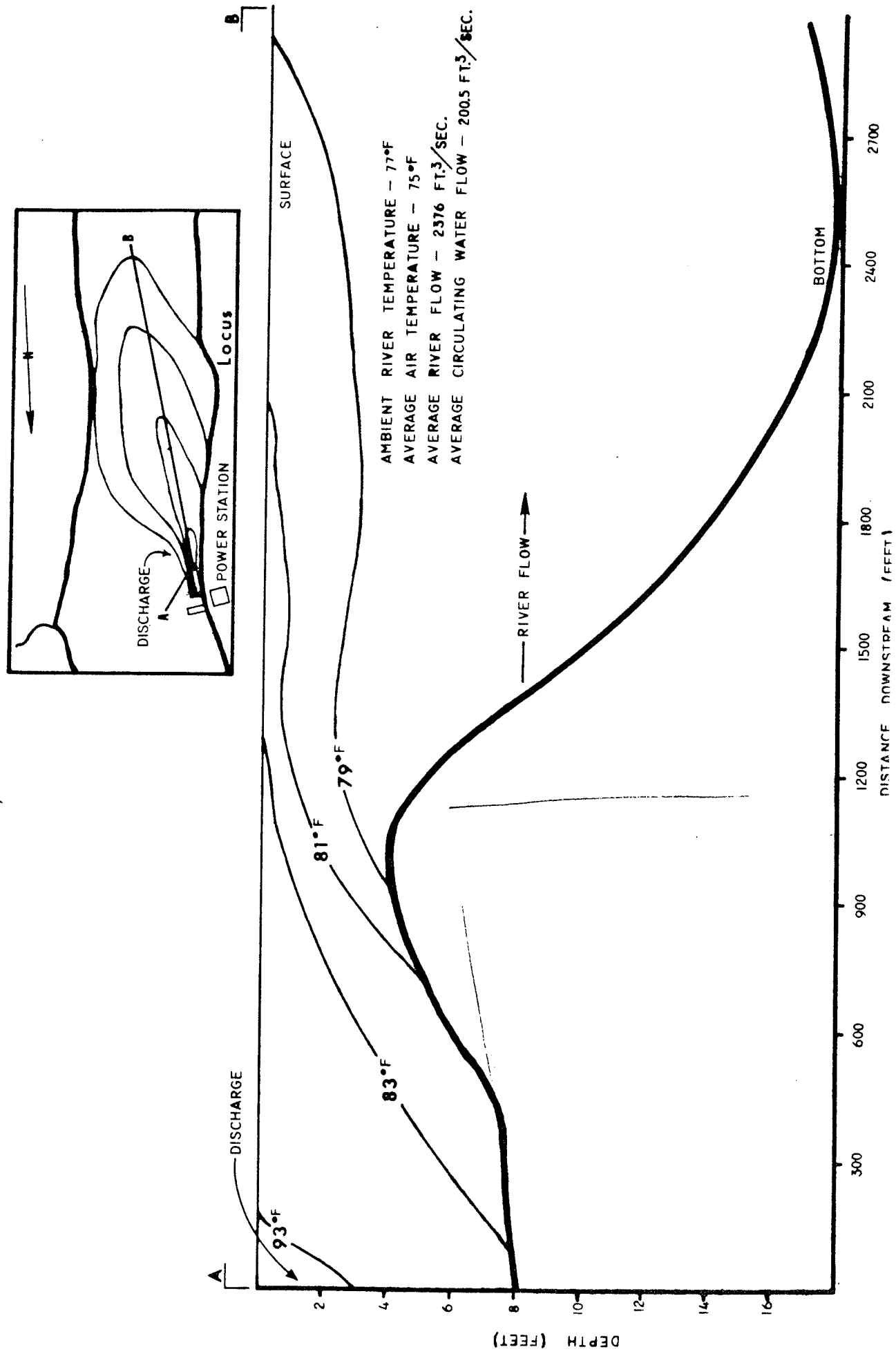


FIG 9. SONIC TRACKING of AMERICAN SRAD, *Alosa sapidissima* (Wilson)
in the VICINITY of the MITOM POWER STATION
SURVEY OF 5/31/74 - 6/22/74

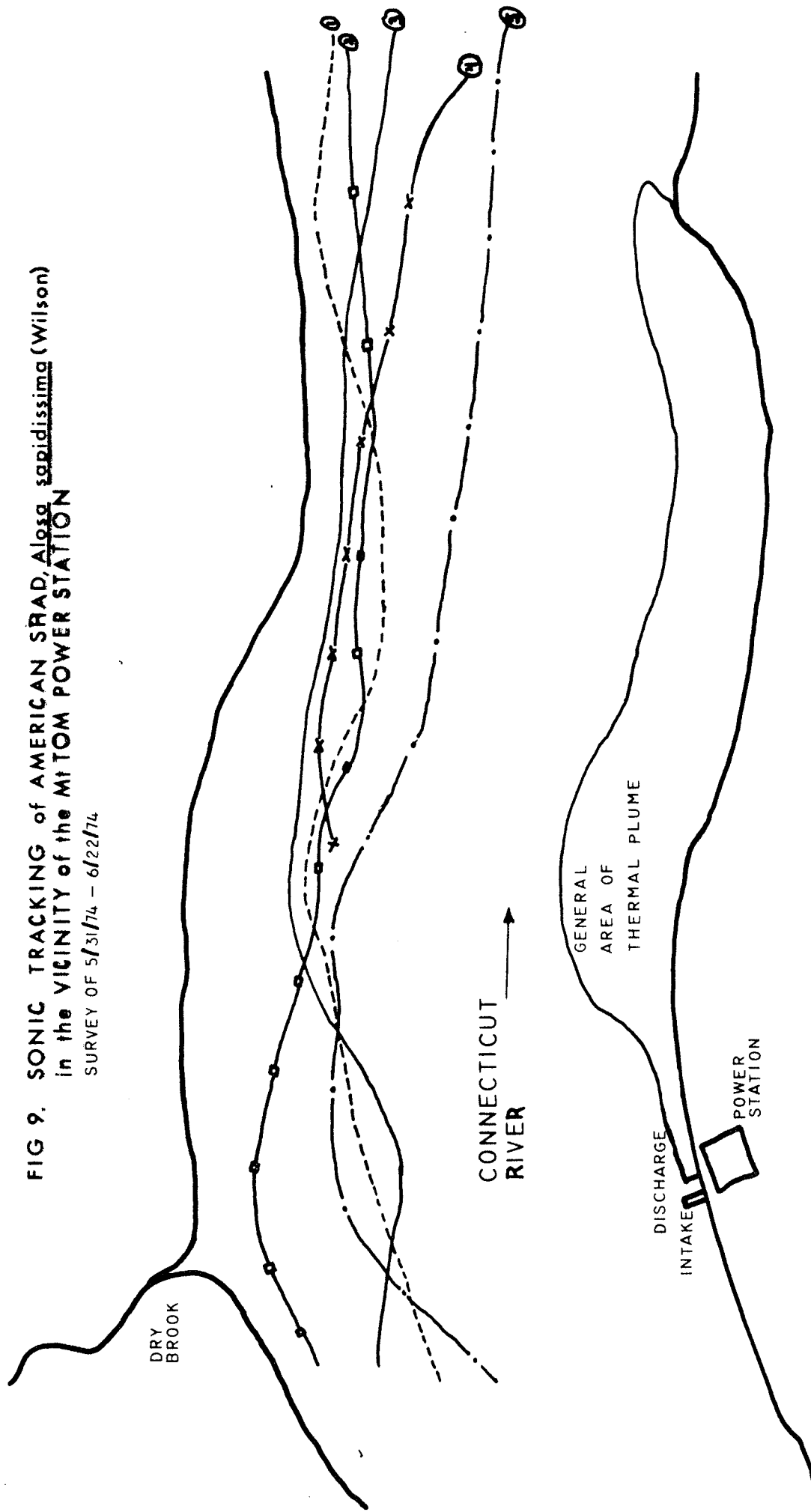


Table 1. Temperatures, Flow and Plant Load at the Mt. Tom Power
Station, Summer of 1974.

<u>Month</u>	<u>Ambient River Temperature°F</u>	<u>Average Discharge Temperature°F</u>	<u>Thermal Increase Temperature°F</u>	<u>Average River Flow CFS</u>
June	67	82	15	9,721
July	74	90	16	8,067
August	76	90	14	3,766
September*	71	84	13	7,099

*from September 1-17, 1974

Table 3.
Temperature and Dissolved Oxygen Profiles at Mt. Tom, September 5, 1974

Station		Sur- face	2.0'	4.0'	6.0'	8.0'	10.0'	12.0'	14.0'	16.0'	18.0'	20.0'	22.0'	24.0'	26.0'	28.0'
A	Temp. D.O.	°F ppm	65.8 9.3	65.1 9.1	65.1 9.1	65.1 9.1	65.1 9.0	65.1 9.0	65.1 9.0	65.1 8.9						
B	Temp. D.O.	°F ppm	65.1 9.0	65.1 9.2	64.9 9.0	64.9 9.0	64.9 9.0	64.9 9.0	64.9 8.9	64.9 8.9	64.9 8.8	64.9 8.8				
C	Temp. D.O.	°F ppm	65.5 9.1	65.1 9.0	65.1 8.9	65.1 8.9	65.1 8.9	65.1 8.9	65.1 8.9	65.1 8.9	65.1 8.8	65.1 8.8	65.1 8.8	64.9 8.7	65.1 8.6	
D	Temp. D.O.	°F ppm	77.0 12.5	76.5 11.7	73.8 10.5	68.7 9.5	68.2 8.9									
E	Temp. D.O.	°F ppm	65.7 9.2	65.1 9.2	65.1 9.1	65.1 9.0	65.1 9.0	65.1 8.9								
F	Temp. D.O.	°F ppm	72.1 10.9	69.0 10.3	67.8 9.6	67.8 9.0										
G	Temp. D.O.	°F ppm	65.8 9.2	65.7 9.2	65.7 9.1	65.7 9.1	65.7 9.1	65.5 9.0	65.5 9.0							
H	Temp. D.O.	°F ppm	65.8 9.2	65.7 9.1	65.7 9.1	65.7 9.1	65.7 9.1	65.7 9.1	65.7 9.1	65.7 9.0						
I	Temp. D.O.	°F ppm	67.5 9.5	66.6 9.4	66.2 9.4	66.2 9.0										
J	Temp. D.O.	°F ppm	65.8 9.0	65.8 9.1	65.8 9.1	65.8 9.1	65.8 9.1	65.8 9.1	65.8 9.1	65.8 9.1	65.8 9.1					
K	Temp. D.O.	°F ppm	69.8 9.9	69.8 10.2	69.8 9.2	68.5 9.4	68.4 9.8	68.0 9.5	65.8 9.1	65.8 9.1	65.7 9.0	65.7 9.0	65.7 9.0	65.7 9.0	65.7 9.0	65.7 9.0
L	Temp. D.O.	°F ppm	66.0 9.3	65.8 9.3	65.8 9.2	65.8 9.3	65.8 9.2	65.8 9.2	65.8 9.2	65.8 9.2	65.8 9.1	65.8 9.1	65.8 9.1	65.8 9.1	65.8 9.1	65.8 9.1
M	Temp. D.O.	°F ppm	66.9 9.4	66.9 9.4	66.2 9.4	66.0 9.2	65.8 9.2	65.8 9.2	65.8 9.2	65.8 9.2	65.8 9.1	65.8 9.1	65.8 9.1	65.8 9.1	65.8 9.1	65.8 9.1
N	Temp. D.O.	°F ppm	67.5 9.6	66.2 9.5	66.6 9.5	66.2 9.4	66.0 9.4	66.0 9.2	65.8 9.0	65.8 9.0	65.8 9.0	65.8 9.0	65.8 9.0	65.8 9.0	65.8 9.0	65.8 9.0
O	Temp.	°F	65.8	65.8	66.2	65.8	65.8	66.0	65.8	65.8	65.8	66.0	65.8	65.8	65.8	65.8

Table 4. Total Available Chlorine (ppm) Analysis at Mt. Tom Power Station During the Summer of 1974.

<u>Date</u>		<u>Above Intake</u>	<u>Below Discharge</u>	<u>In Effluent</u>
July 31, 1974	Free available chlorine	0.025	0.244	
	Combined available chlorine	0.023	0.109	0.305
	Total available chlorine	0.048	0.353	
August 2, 1974	Free available chlorine	0.054	0.059	
	Combined available chlorine	0.020	0.129	0.114
	Total available chlorine	0.074	0.188	
August 7, 1974	Free available chlorine	0.038	0.094	
	Combined available chlorine	0.023	0.045	0.078
	Total available chlorine	0.061	0.139	
September 24, 1974	Free available chlorine	0.012	0.042	
	Combined available chlorine	0.004	0.018	0.044
	Total available chlorine	0.016	0.060	

Table 5. Mt. Tom Plankton Sampling - Plankton Biomass Determination

<u>Station</u>	<u>July 19, 1974^o</u>	<u>July 31, 1974^o</u>	<u>August 8, 1974^o</u>	<u>August 21, 1974*</u>
A	0.00013 g/m ³	0.0023 g/m ³	0.00083 g/m ³	0.0187 g/m ³
B	0.0016 "	0.0078 "	0.02976 "	0.0012 "
C	0.00027 "	0.0012 "	0.0368 "	0.0044 "
D	0.00018 "	0.00113 "	0.0000015"	0.0025 "
E	0.00016 "	0.000904"	0.0048 "	0.0031 "
F	0.00026 "	0.00116 "	0.0049 "	not available

*using ash-free biomass determination

^ousing ash-weight

Table 6. Total Number of Benthic Organisms at Each Station, 1 June to 1 October, 1974. (Percent of total number in parentheses).

Station Number	Annelida	Bryozoa	Collembola	Coleoptera	Cladocera	Diptera	Ephemeroptera	Gastropoda	Megaloptera	Odonata	Ostracoda	Pelecypoda	Plecoptera	Trichoptera	Turbellaria	Totals
1	32 (8)		1 (<1)	8 (2)		223 (58)	84 (22)			11 (2)	1 (<1)	2 (<1)	3 (<1)	16 (4)		381
2	20 (10)			1 (<1)		114 (55)	37 (18)		1 (<1)	3 (1)			2 (1)	22 (11)		200
3	5 (2)					162 (95)				1 (<1)				1 (<1)		169
4	1 (<1)	2 (1)				52 (50)	44 (42)					1 (<1)		4 (3)		104
5	2 (<1)			1 (<1)		433 (94)	15 (3)			1 (<1)	1 (<1)	2 (<1)		2 (<1)		457
6					3 (<1)	264 (77)	55 (16)	2 (<1)			1 (<1)	1 (<1)		13 (3)	2 (<1)	341
7	8 (5)	6 (3)	1 (<1)	1 (<1)		124 (79)	2 (1)	1 (<1)				1 (<1)		9 (5)	4 (2)	157
8	9 (3)			1 (<1)		236 (91)	3 (1)			2 (<1)		1 (<1)		3 (1)	3 (1)	258
9	1 (1)			1 (1)		47 (50)	41 (43)	1 (1)		1 (1)		1 (1)			1 (1)	94
10	5 (2)			1 (<1)		253 (86)	26 (9)			2 (<1)		1 (<1)		1 (<1)		289
Totals	83 (3)	8 (<1)	2 (<1)	14 (<1)	3 (<1)	1908 (77)	307 (12)	4 (<1)	1 (<1)	21 (<1)	3 (<1)	10 (<1)	5 (<1)	71 (2)	10 (<1)	2450

Table 7. Diversity of Benthic Organisms and Sampling Station Characteristics.

<u>Station Number</u>	<u>Influence of Heated Discharge</u>	<u>Depth (ft.)</u>	<u>Substrate Type</u>	<u>Diversity Index</u>
2	none	8	sand/gravel/silt	1.8
3	very much	4	sand/gravel/silt	0.3
9	little	14	sand/gravel/silt	1.4
4	little	16	sand/gravel	1.4
1	none	14	gravel/silt	1.8
10	little	14	sand/silt	0.7
8	little	32	sand/silt	0.6
6	little	18	coarse sand/silt	1.1
5	very much	6	gravel/detritus	0.4
7	little	34	gravel/detritus	1.2

Table 8. List of Fishes Collected in the Connecticut River,
Holyoke, June 17 to October 1, 1974.

American Eel	<u>Anguilla rostrata</u>
American Shad	<u>Alosa sapidissima</u>
Black Crappie	<u>Pomoxis nigromaculatus</u>
Bluegill	<u>Lepomis macrochirus</u>
Carp	<u>Cyprinus carpio</u>
Channel Catfish	<u>Ictalurus punctatus</u>
Largemouth Bass*	<u>Micropterus salmoides</u>
Pumpkinseed*	<u>Lepomis gibbosus</u>
Sea Lamprey*	<u>Petromyzon marinus</u>
Smallmouth Bass	<u>Micropterus dolomieu</u>
Spottail Shiner	<u>Notropis hudsonius</u>
White Crappie	<u>Pomoxis annularis</u>
White Perch	<u>Morone americana</u>
White Sucker	<u>Catostomus commersoni</u>
Yellow Perch	<u>Perca flavescens</u>

*fish species sampled above thermal discharge only

Table 9. Total Number and Sizes of Fishes Sampled in the Thermal Plume, June 17 to October 1, 1974.

Size Range (Ins.) Species	Carp	Bluegill	Smallmouth Bass	Black Crappie	White Crappie	White Perch	Channel Catfish	Spottail Shiner	Shad	Yellow Perch
1.5- 1.9									2	
2.0- 2.4								1	2	
2.5- 2.9								11	1	
3.0- 3.4			1			3		1	2	
3.5- 3.9						1		1	1	
4.0- 4.4			1			1		4		
4.5- 4.9						1		2		
5.0- 5.4						3		1		
5.5- 5.9				1						
6.0- 6.4						3				
6.5- 6.9		1				2				
7.0- 7.4		2	1			2				
7.5- 7.9		1				2				
8.0- 8.4				2		1				
8.5- 8.9			1	1		1				
9.0- 9.4			2	1	2	2				1
9.5- 9.9					1					
10.0-10.4							2			
11.5-11.9							1			
14.0-14.4			1							
16.0-16.4							1			
17.5-17.9	1									
22.5-22.9	1									
23.0-23.4	2									
23.5-23.9	1									
24.0-24.4	1									
24.5-24.9	1									
>25.0	2									
Total No.	9	4	7	5	3	22	4	21	8	1
Pounds	52.65	1.45	2.75	1.9	1.4	4.5	2.7	0.3	-	.3

Table 10.

Total Number and Sizes of Fishes Sampled Out of the Plume,
June 17 to October 1, 1974.

Size Range (Ins.) Species	Yellow Perch	White Perch	Pumpkinseed	Carp	White Sucker	Spottail Shiner	Black Crappie	White Crappie	Largemouth Bass	Smallmouth Bass	Channel Catfish	Bluegill
1.5- 1.9										1		
2.0- 2.4			1			2						
2.5- 2.9										1		
3.0- 3.4										1		
3.5- 3.9												2
4.0- 4.4	1		1									
6.0- 6.4										2		
6.5- 6.9	1											
7.0- 7.4	4											1
7.5- 7.9	2						1					2
8.0- 8.4	5						1					1
8.5- 8.9	5											1
9.0- 9.4	1	1						1	1			
9.5- 9.9	2											
11.5-11.9											1	
14.0-14.4					1							
15.0-15.4					1							
15.5-15.9											1	
17.0-17.4					1							
19.5-19.9				1								
24.5-24.9				1								
> 25.0				1								
Total No.	21	1	2	3	3	2	2	1	1	5	2	7
Pounds	6.25	0.5	0.1	21.9	4.7	-	0.5	0.2	0.5	0.3	2.2	2.35

Table 11. Average Condition Factor for Selected Species of Fish Sampled Within and Upstream of the Thermal Plume, June 17 to October 1, 1974. (Number of fish in parentheses).

<u>Species</u>	<u>Condition Factor of Fish in Plume</u>		<u>Condition Factor of Fish Upstream of Plume</u>	
Carp	0.50	(8)	0.51	(3)
Channel Catfish	0.35	(4)	0.38	(2)
Yellow Perch	0.41	(1)	0.56	(21)
White Perch	0.71	(17)	0.64	(1)
Bluegill	1.08	(4)	1.09	(8)
Smallmouth Bass	0.55	(6)	0.46	(2)
Black Crappie	0.71	(5)	0.50	(2)
White Crappie	0.49	(5)	0.27	(1)

Table 12.

Fish Impinged, Mt. Tom Station, Summer of 1974

X - Actual Count (X) - Weekly Estimate

Species and Size Range

[illegible]